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Avery, Oswald Theodore (21 Oct. 1877-20 Feb. 1955), bacteriologist, was born in Halifax, Nova Scotia, Canada, the son of Joseph Francis Avery, a Baptist minister, and Elizabeth Crowdy. Avery's family moved in 1887 to New York City, where he attended New York Male Grammar School. He received his diploma from that institution in 1893 and continued his education at the Colgate Academy. In 1896 he entered Colgate University, from which he received a B.S. in 1900. He then began the study of medicine at Columbia University's College of Physicians and Surgeons and received an M.D. in 1904. After completing his medical studies, Avery joined the clinical practice of a group of surgeons in New York City. He related well to patients, but because clinical work did not satisfy him intellectually or emotionally, he left the practice around 1907 and worked for a time with the New York City Board of Health and then the Sheffield Dairy Company in Brooklyn as a milk bacteriologist. Later in 1907 he became a bacteriologist at the Hoagland Laboratories in Brooklyn, where director Benjamin White became so impressed with Avery that within a short time he appointed him chief of the division. Avery's work on bacteria and their relationship to infectious disease attracted the attention of Rufus Cole, director of the hospital of the Rockefeller Institute (now University) of New York City, who invited him to become a member of its staff. Avery joined the institute in 1913 and became a full member there in 1923.

In his first fifteen years at the institute, Avery developed his knowledge of the pneumococcus with the assistance of a number of colleagues, including Karl G. Dernby, Glen E. Cullen, Theodore Thjotta, Hugh J. Morgan, and James M. Neill. His most significant early work began in 1916 when he joined with Alphonse R. Dochez, who had just discovered a specific chemical substance produced by pneumococci that was precipitated by antigen prepared against the same organism. A study of the material's chemical, which they named the specific soluble substance (SSS), showed it was not a degradation product but a true chemical produced by pneumococci. They also demonstrated that in acute pneumonia, pneumococci release this material into the bloodstream, and it passes into the urine. Further work in the early 1920s with Michael Heidelberger proved the SSS was a capsular polysaccharide specific for each pneumococcus.

The studies of organic chemist Walter Goebel, who joined Avery in 1924, demonstrated that the Friedlander bacillus (Klebsiella pneumonia) capsular polysaccharide not only bestowed immunologic specificity, but it also bore a close chemical resemblance to the type II pneumococcus polysaccharide. Even more significant was the demonstration that mice infected with type II pneumococci could be protected from pneumonia with serum from rabbits vaccinated with the encapsulated Friedlander bacilli. Furthermore, mice infected with Friedlander bacilli could be protected with pneumococci type II serum. These impressive findings demonstrated that immunity was not bestowed through biological direction but by the chemical configuration of the capsular substance.

In the late 1920s Frederick Griffith demonstrated that type II smooth (S) virulent pneumococci could be isolated from the blood of mice inoculated with large doses of

nonvirulent pneumococci type I with a rough capsule (R) if they were injected at appropriate intervals prior to sacrifice with killed type II (S) pneumococci. Impressed with these findings, Avery encouraged Martin H. Dawson, a young Canadian scientist, to investigate the conditions most favorable for producing the transformation of the pneumococci from the rough to the smooth form. Dawson confirmed and extended Griffith's findings. Research physician James L. Alloway added to these studies by finding that the transformation could be brought about with a soluble fraction prepared from S pneumococci made by dissolving the cells in sodium deoxycholate and removing the cell fragments by filtration (Berkefeld filter). In 1935 Avery's colleague Colin MacLeod improved the method by killing the bacteria that produced the destructive enzyme before subjecting the material to solubilization with sodium deoxycholate. MacLeod's replacement, Maclyn McCarty, an investigator with a background in biological chemistry, advanced the understanding by showing the transforming substance of the viscous fraction was deoxyribonucleic acid (DNA). Avery, MacLeod, and McCarty published their classic paper "Transformation of Pneumococcal Types Induced by a Deoxyribonucleic Acid Fraction Isolated from Pneumococcus Type III" in the Journal of Experimental Medicine in 1944, disclosing that DNA was the hereditary substance. Although this paper initiated the genetic revolution, in it, Avery and his collaborators expressed the relevance of their work in muted tones. Despite the fact that these investigators made every effort to free their DNA preparation from contaminating protein and carbohydrate, other scientists continued to maintain that the transformation was produced by small amounts of contaminants bound to DNA. Because of this objection, total acceptance of DNA as the hereditary substance did not occur until 1952, when Alfred Hershey and Margaret Chase demonstrated, with double-labeled phage, that DNA alone was the hereditary substance.

Called "Fess" by his friends, Avery was a slender man, always neatly dressed, who warmly interacted with friends and colleagues. He had the ability to transform a conversation into a playful performance with gestures, mimicry, and vivid analysis. During his early years at the institute, he spent his summers by the sea in Gloucester, Massachusetts, where he developed a love for sailing. Through his friend Allen Chesney, he was introduced to Deer Island, Maine, where he spent the remaining summers of his life. He never married. Avery retired in 1948 and moved to be with his brother in Nashville, Tennessee, where he died.

Bibliography

A few of Avery's papers are preserved in the archives of Rockefeller University, New York City, and the Tennessee State Library and Archives in Nashville. The development of Avery's scientific career can be followed in his published papers, the detailed annual reports he submitted to the board of directors of the Rockefeller Institute, and the reports to the trustees submitted by the director of the Rockefeller Hospital. Biographical accounts include Alphonse R. Dochez, "Oswald T. Avery," National Academy of Sciences, Biographical Memoirs 32 (1958): 32-49, and Rene J. Dubos, "Oswald Theodore Avery, 1877-1955," Biographical Memoirs of Fellows of the Royal Society 2 (1958): 35-48. See also Dubos, The Professor, the Institute, and DNA (1976). An obituary is in the New York Times, 21 Feb. 1955.

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